

# Crowd Emotion Recognition

**Affective computing for empathic behavior change**  
**University of Fribourg**

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# Agenda

- Introduction
- Literature review questions
- Methods
- Results
- Synthesis table
- Challenges
- Conclusion

# Crowd Emotion Recognition



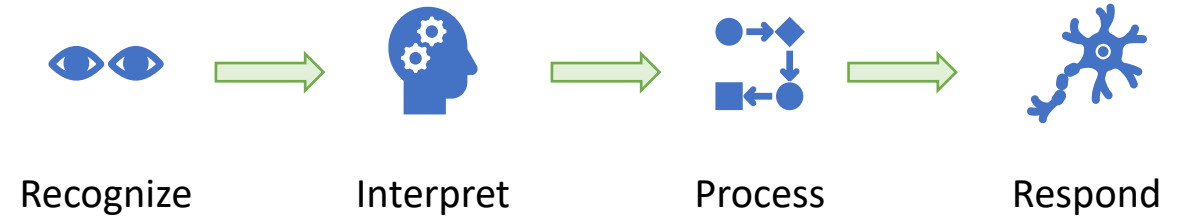
Crowd



Emotion



Affective Computing



**Crowd emotion recognition**

# Research Questions:

RQ1

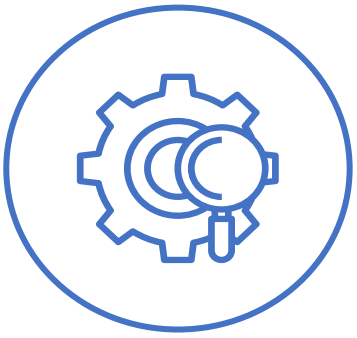
What is the pipeline followed to build crowd emotion recognition?

RQ2

In which context is crowd emotion recognition utilized?

RQ3

Can crowd emotions be induced in digital experiences?



# Methods



Semantic Scholar

Crowd emotion detection

Crowd emotion analysis events

Affective Haptic Devices induce emotions



15 -17 recent and interesting articles selected



## Criteria to analyze crowd emotion recognition

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- Context
- Input modalities
- Feature Extraction
- Algorithm
- Evaluation
- Output

## Context (RQ2)

- Retail experience [8]
- Entertainment industry
  - Movies & Concerts [3,4]
- Public safety
  - Violence [14,16]
  - Anomaly detection [17]



Retail experience [8]

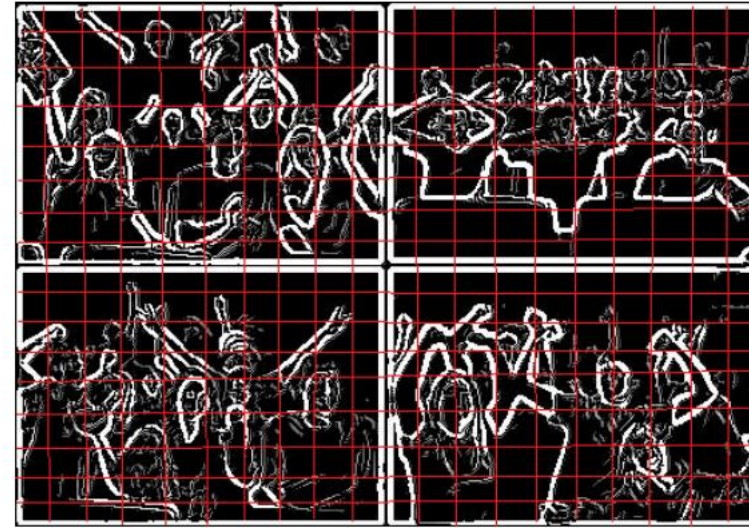
# Input modalities

- Images<sub>[8,10,14]</sub>
- Videos <sub>[1,6,7,9,10,11,16,17]</sub>
- Sound <sub>[3,4]</sub>

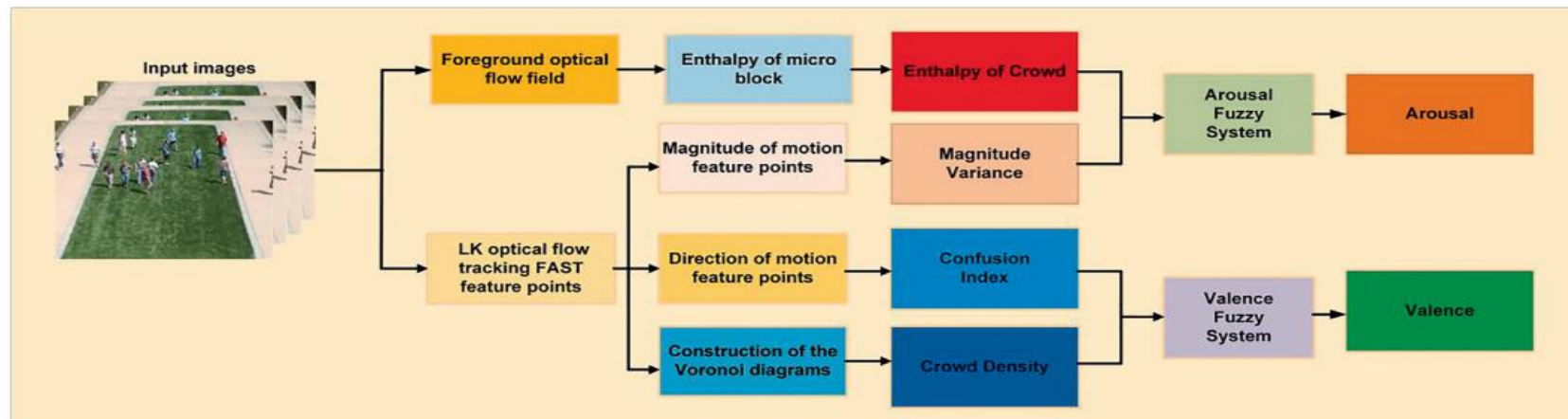


# Feature extraction

- Crowd enthalpy, magnitude variance, crowd density, confusion index [16,17]
- Crowd enthalpy and OCC model [6]
- Edges [9]
- Facial features [8,14]
- Sound features [3,4]



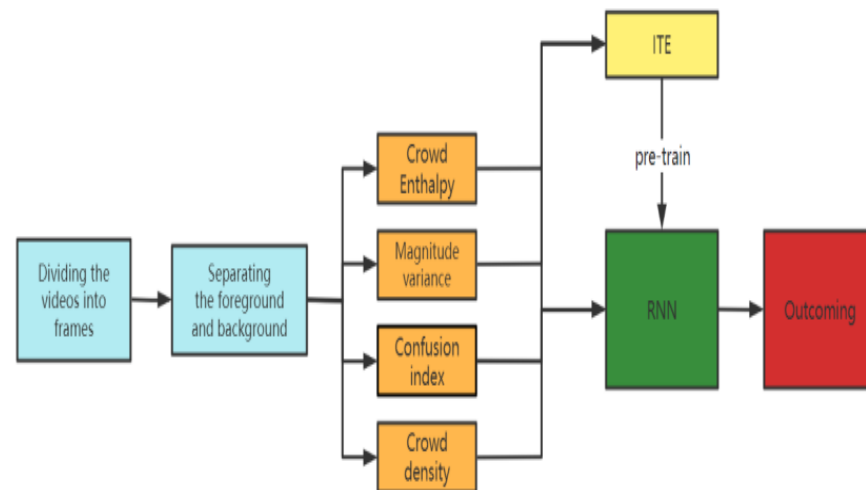
Edge extraction[9]



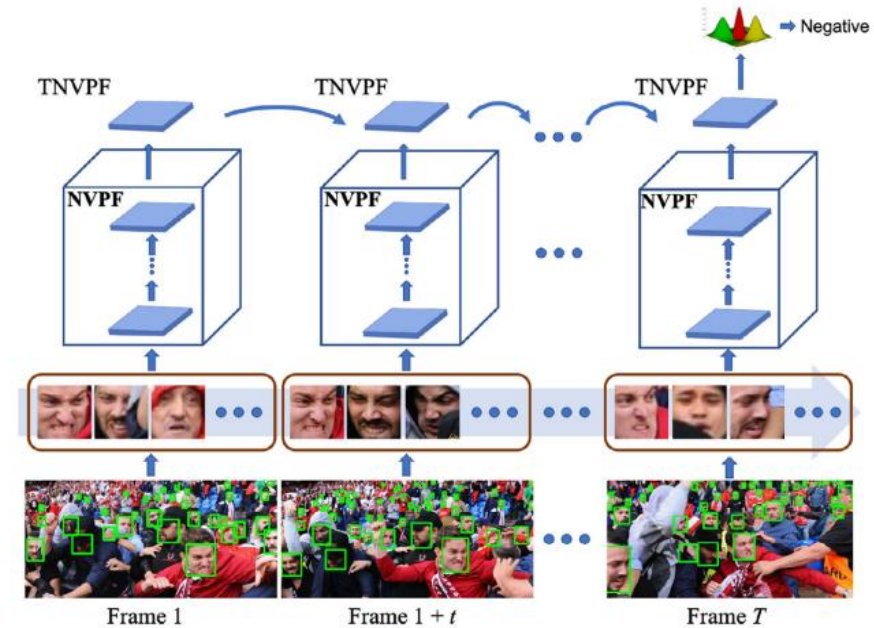
Feature extraction [17]

# Algorithm

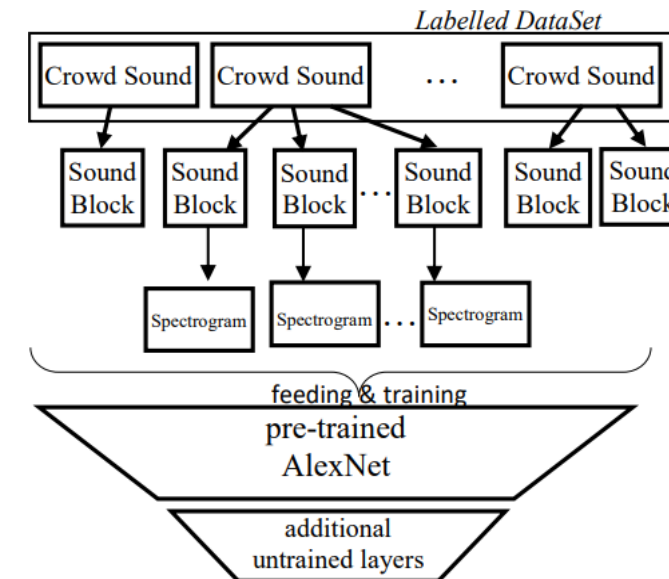
- CNN[8]
- 2D CNN with rectifier linear unit[14]
- CNN with NVPF and TNVPF[10]
- RNN[16]
- Fuzzy theory[17]
- SVM[9,11]
- Crowd sound classification- CNN [4]



Spatiotemporal feature extraction[16]



Group Level Emotion [10]



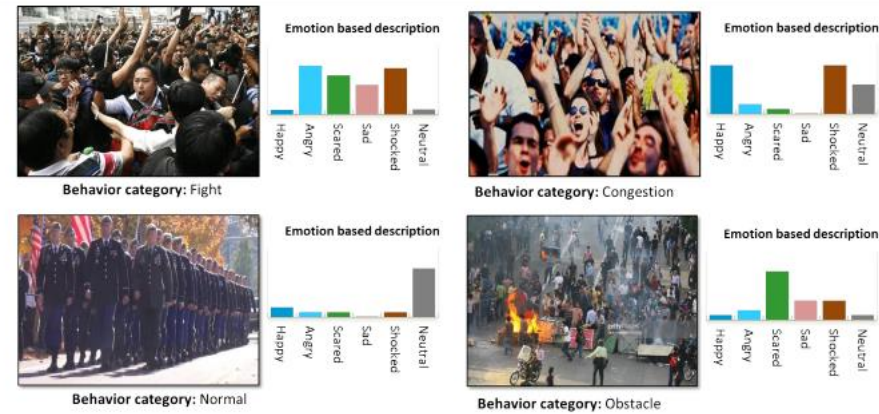
Crowd sound classification[4]

# Evaluation

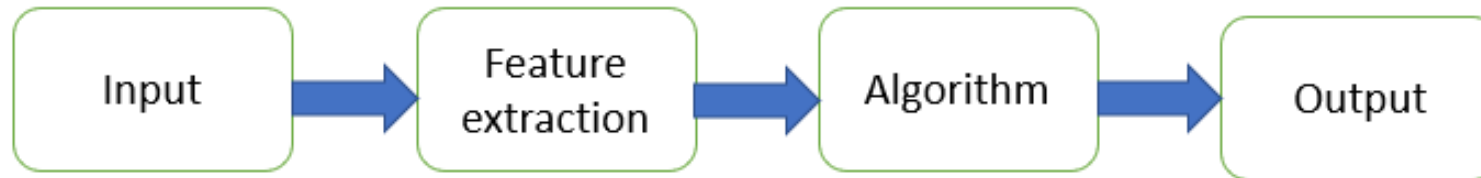
- Offline evaluation
  - public datasets or own datasets.
  - Compared with baseline analysis , without emotion [11]
  - Data split to 80-20%<sup>[4]</sup> or 70-30% <sup>[9]</sup>
  - Simulation in virtual world with different scenario
- Metrics
  - Area Under Curve(AUC), ERR (equal error rate)<sup>[6,7]</sup>, Accuracy, MAE(Mean Absolute error<sup>[17]</sup>), F1 Score <sup>[1]</sup>

# Output

- Crowd behavior prediction [6,7,11]
- Classify crowd emotion [3,4,6,9,10,14]
  - Light the tree[8]
- Valence and Arousal values [17]
- New annotated datasets



Classification of images [11]



Pipeline for crowd emotion recognition (RQ1)

# Synthesis Table

	Causal Spatio-temporal Structure[16]	Evaluation based on fuzzy inference[17]	Crowd Emotion to light up smart Christmas Tree[8]	ESLCE: Emotional Sounds[1]	CE sounds: spectrogram-based analysis using CNN[4]	NVPF to group-level emotion recognition[10]	2D ConvNets[14]	CED Bio-inspired[1]	Edge based superimposed CER[9]	Crowd Abnormal Behavior Detection[7]	DL Models Combined with CE Models [6]	Emotion-Based Crowd Representation [11]
Year	2022	2021	2019	2021	2019	2022	2020	2014	2016	2020	2020	2016
Aim	instead of traditional DL, causal inference with RNN	to measure the crowd emotion-using fuzzy inference	Light up Christmas Tree	Curate a dataset for detecting crowd emotion with sound	CE from speech and sounds clips	Multi level emotion classification	CE using 2D CNN	detection of crowd emotion and simulate it.	spontaneous detection of emotion even with occlusion	using motion and emotion to detect anomaly	OCC with DL methods to detect abnormality.	Use crowd motion and emotion to find abnormality.
Context	Avoid violence	Anomaly detection	Retail experience	Sports Events, movies	Entertainment	Emotion in a crowd with different groups	Avoid violence during protests	Anomaly detection	Indoor crowd events	abnormality	abnormality	abnormality
Methodology	Cs-RNN with ITE	Fuzzy rules	CNN	RandomForest classification	visual transfer learning	CNN, NVPF, TNVPF	2D-CNN	bayesian networks, bio-inspired memory	edge detection , SVM classifier	dual channel CNN and SVM	CNN, OCC emotion model	SVM classifier
Input	Video	Video	Image	sounds	sounds	Video and images	Image	Video	Video	Video	Video	Video
Feature extraction	crowd density, crowd enthalpy, magnitude variance, confusion index	crowd density, crowd enthalpy, magnitude variance, confusion index	Sentiment extraction from photos	Loudness, audio-specific features	frequency-amplitude features	individual facial detection (bottom-up)	facial features using DL	Emotion and motion	edges and motion from crowd	Emotion and motion	crowd entropy, emotion from OCC model	low level features from dense trajectories
Output	classification of emotion	valence, arousal score	light the tree	classification of emotion	classification of emotion	classification of multiple level of emotions	classification of emotion	classification of emotion	classification of emotion	classification of the behavior	classification of behavior	classification of behavior
Evaluation	CS-RNN - performed better	MRE, MAE are relatively low	accuracy good for happy and neutral	F1 score Disapproval is poorly identified	random train-test better than manual selection	robust and effective	Good accuracy is obtained	Accuracy is good (except for Herding)	Accuracy and recall, happy is the best, anger is the least	AUC,ERR and accuracy	Accuracy better with emotion AUC and EER	Good accuracy when emotion is considered
Dataset	MED	own dataset	own dataset	own dataset	own	own-GEVC	self curated	simulated	own	UCSD	MED, UCSD	own
No of emotions	6	12	4	3	3	3	5	2	7	7	don't mention	6



# RQ3: Induce emotions

- Affective Haptic Devices:
  - Wearable technology, provides haptic feedback by vibrating and applying pressure.
- Emotion mapping:
  - varying the vibration patterns, bio-signal haptic feedback<sup>[15]</sup>
- Design:
  - vest, controller<sup>[13]</sup>
- Limitation:
  - Just AHD is not enough to induce emotions( need visual and acoustic aid )<sup>[5]</sup>

# Challenges

- Computationally expensive
- Emotions in people are different[14]
- Privacy
- Ethics
  - *"we risk losing control not just of our data or privacy, but of our bodies themselves"* according to Morelli [13].

# Conclusions

**How to build crowd emotion recognition model ?**

- Input modalities
- Feature extraction
- Machine learning algorithms & Emotion detection
- Output classification

**Simulate emotions using Affective Haptics Devices**

- Limitation:**
- Is not an extensive study



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Thank You !!!  
Questions?  
**Crowd Emotion Recognition**

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